US Army Corps of Engineers

Topographic Engineering Center

Digital Data Digest

Volume 5, Number 2 Fall 1996

Army and NIMA work with Warfighters to evaluate high-resolution digital terrain data bases

High-resolution terrain data took a step out of Virtual Reality into reality during the Operational Warfighter Evaluation conducted at Fort Benning, Ga., July 16-18, 1996. This exercise brought together Army, Marine Corps and Special Operations experts to hike, climb, and crawl through the cinder-block buildings of the McKenna Military Operations on Urban Terrain (MOUT) site and then compare what they experienced to special high-resolution terrain data and computer-generated synthetic environments designed to support dismounted infantry operations in urban terrain.

An interagency working group consisting of the U.S. Army Topographic Engineering Center (TEC), National Imagery and Mapping Agency (NIMA), Terrain Modeling Project Office (TMPO), U.S. Army Dismounted Battlespace Battle Lab (DBBL), and the Institute for Defense Analysis (IDA) designed and executed the evaluation to allow Warfighters to experience detailed terrain data bases produced for advanced Warfighting Experiments and provide input to the development process. These high-fidelity data bases are the foundation for synthetic environments that will enable Army leaders to quickly model, evaluate, gain insight into future operational capabilities and support operations.

High-resolution highs/headaches

One of the first problems the working group wrestled with was the enormous variety of terrain data that was created for the 15 building sites, adjacent airfield, and sandy brown eroded hills. To investigate different methods of producing high-resolution data, TEC, NIMA, and contractors created no less than four sets of digital mapping data, eight sets of elevation data (including "1-meter" data), and 3-D building models with interior rooms, multiple levels, and realistic details. Members of the working group sorted through this information, identifying "terrain walks" in and around the actual and virtual mock village. Observation points on the ground were surveyed and correlated with matching locations in the data bases to ensure consistency. Project scientists also initiated a systematic review of never-before-seen data files with names like "ITD++" and "wrinkles." They consolidated the information into a geographic information system (GIS) so the Warfighters would have flexible access to the information that supports virtual simulations. Because the digital data incorporated so much detail, the image generation systems used for the virtual simulation were jammed to capacity, yielding flickering scenes of buildings and disjointed virtual landscapes. Several weeks later, the team brought high-end image generators into the effort, enabling them to generate fully functional high-resolution synthetic terrain to support the July evaluation.

Photo #1

Cover

2 1/8 x 2 7/16

2 1/4 x 2 9/16

94%

Warfighter and Evaluation Team members survey underground tunnel system at the McKenna MOUT site.

Evaluation activities

The Operational Warfighter Evaluation was conducted by teams

(Continued on page 2.)

Form SF298 Citation Data

Report Date ("DD MON YYYY")	Report Type	Dates Covered (from... to) ("DD MON YYYY")
00Oct1996	N/A	

Title and Subtitle Army and NIMA Work with Warfighters to Evaluate High-Resolution digital Terrain Data Bases	**Contract or Grant Number**
	Program Element Number
Authors	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) US Army COrps of Engineers ATTN: Tammy Scroggins, (703) 428-6902 Topographic Engineering Center Alexandria, VA	**Performing Organization Number(s)**
Sponsoring/Monitoring Agency Name(s) and Address(es)	**Monitoring Agency Acronym**
	Monitoring Agency Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited	
Supplementary Notes	
Abstract High-resolution terrain data took a step out of Virtual Reality into reality during the Operational Warfighter Evaluation conducted at Fort Benning, Ga., July 16-18, 1996. This exercise brought together Army, Marine Corps and Special Operations experts to hike, climb, and crawl through the cinder-block buildings of the McKenna Military Operations on Urban Terrain (MOUT) site and then compare what they experienced to special high-resolution terrain data and computer-generated synthetic environments designed to support dismounted infantry operations in urban terrain.	
Subject Terms	
Document Classification unclassified	**Classification of SF298** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** unlimited
Number of Pages 18	

Army, ***continued from page 1***

Photo #2

5 x 3 1/2

4 1/2 x 3 1/8

111%

Warfighters and Evaluation Team members survey "Town Hall" at the McKenna MOUT site.

of Warfighters in three phases. In Phase I, the teams conducted terrain walks over three designated routes in the vicinity of the McKenna MOUT site. At designated points along each route, participants recorded terrain observations. In Phase II, the evaluators viewed the virtual terrain along the same route they walked during Phase I, and provided comments regarding the similarities and differences they observed between the real terrain and the simulated terrain. In Phase III, each team received background briefings on digital data and reviewed various digital feature data and imagery that was used to generate the synthetic terrain. They completed several questionnaires rating the operational importance of various features in the digital data, required levels of detail, and necessary accuracy. The Warfighters also assessed the utility of the various products to support operational needs during crisis management, mission planning, mission rehearsal, command and control, training, combat developments, and test and evaluation.

Warfighter response

Most participants commented positively on the overall quality of the data bases. However, they noted many aspects they would like improved, especially for use by dismounted infantry. These improvements included better methods to capture and represent vegetation, drainage, and undergrowth, subtle variations in the terrain, such as sewers and other underground structures. All the participants, evaluators and coordinators of the exercise left with increased experience and understanding of the problems and potential of this type of information.

What's next

TMPO is sponsoring a Technical Exchange Meeting (TEM) on High-Resolution Terrain Data during November 1996. A joint effort is underway to tabulate and prioritize Warfighter responses. These will be presented at the TEM along with analysis of a number of problematic issues, such as absolute accuracy determination and future requirements. This feedback will be presented to the user community and TEC developers to help generate more refined versions of the McKenna data base. TEC scientists also are working with Army users to develop refined data base requirements and better production methods for this new type of geospatial information. (Jeff Harrison, U.S. Army Topographic Engineering Center, CETEC-PD-DR, 7701 Telegraph Road, Alexandria, VA 22315-3864, DSN 328-6784, 703-428-6784 or jharriso@tec.army.mil.)

TEC team members assist in Bosnian minefield data base development activities

The summer of 1996 proved to be a challenging one for three team members from the U.S. Army Topographic Engineering Center (TEC) who traveled to Tuzla, Bosnia, to participate in the development of a minefield data base program. The trio spent more than 2 weeks in-theater during July to perform the initial data acquisition duties necessary to fill the data base. This seemingly straightforward task was accomplished, however, with an intoxicating dose of "Army Greening."

Minefield Data Base Program

The Minefield Data Base Program (MDP), sponsored by the U.S. Army Materiel Command (AMC) Countermine Task Force under Brig. Gen. Beauchamp, was developed by Tom Steck of the U.S. Army Communications and Electronics Command (CECOM) Research Development and Engineering Center, Night Vision and Electronic Sensors Directorate. It will serve as a digital clearinghouse of locally produced minefield sheets and is designed to facilitate minefield detection, recording and clearing processes both in Bosnia and future areas of conflict. The program will consist of four components. A Global Positioning System-based Digital Reconnaissance System (DRS) will be used to define the locational bounds of a suspected minefield. A minefield data base computer system will be located at various brigade and battalion headquarters and will consist of two Sun UNIX work stations designated as the Terrain Evaluation Module/ Engineer-Operations (TEM/E-OPS) and one Hewlett Packard UNIX work station designated as the TEC-developed Multispectral Imagery Processor (MSIP). A wireless e-mail communication system will serve as a bridge between the DRS and the MSIP. A computer, known as the Digital Map Reporting System (DMRS), will disseminate the

(Continued on page 4.)

Editor's note: The "topo logo" or cube is symbolic of the spatial nature of Digital Topographic Data which can be stored, manipulated, analyzed and displayed in 3-D.

Contents

minefield data through the brigades, battalions and companies.

The development of the MDP involves the coordination of several Army components and Department of Defense (DOD) contractors. TEC is tasked with the initial development stages. These include onsite data acquisition (scanning of hard-copy mine sheets), MSIP deployment and development of data base query and map output capabilities. The U.S. Army Engineer School in Fort Leonard Wood, Mo., is responsible for testing the DRS. CECOM will develop the wireless e-mail communication system. BRTRC Inc. is tasked with developing the DMRS. Other Army components and DOD contractors also have been assigned various additional duties. Of these tasks, only the data base and the DMRS have been fully funded to date.

Mine Action Center

The Mine Action Center (MAC) is located in the heart of the Main Air Base in Tuzla. Housed in a 50-year-old building formerly occupied by the Bosnian military and NATO peacekeeping forces, respectively, the MAC is the focal point of the MDP development activities. Until July 1996, the employees of the MAC processed all hard-copy minefield sheets manually and managed them using a MicroSoft Excel spreadsheet. They currently use Paradox as an interface to invoke scanned minefield sheets. This is an interim measure which will be superseded by the MDP when fully implemented.

Though data base development has commenced, the method of acquiring minefield sheets has not changed. Various Bosnian and Serbian forces who placed the mines are mandated to relinquish their minefield sheets to members of the Implementation Forces (IFOR) in accordance with the Dayton Peace Accords (November 1995). The factions also are responsible for the removal of the mines.

As of July, there were approximately 10,000 minefields in the portion of the Zone of Separation (ZOS) that lies within the American Sector (one of three delineated by the Peace Accords). The ZOS is a 4-kilometer wide demilitarized buffer zone between Bosnia and Serbia. Extrapolation of this minefield density yields an estimate of six to 10 million mines in all of the former Yugoslavia.

For tracking purposes, the MAC logs the minefield sheets in the order they are acquired. The minefield sheets are assigned a reference number, translated into English by Bosnian translators, logged in the Excel spreadsheet and archived in one of 49 4-inch wide letter-size binders. Members of IFOR who need to access the minefield sheets travel to the MAC and compile minefield boundaries on transparency sheets to be overlayed on 1:50,000-scale Topographic Line Maps (TLMs). This cumbersome process will be rendered obsolete by the MDP.

Minefield sheets

Minefield sheets were compiled by the various warring factions on international letter-size paper (210 millimeters x 297 millimeters). All text is in the Serbo-Croatian language. The minefield sheet is a standard format which consists of informational fields and a map location box. The informational fields include such entries as orientation point, types and numbers of mines, placement method, safe lanes, individuals in charge and removal information. A diagram of the minefield is drawn in the map location box. Though the minefield sheet is a standard format, the quality of the entries and diagrams varies significantly. Some drawings are very precise while others consist of crude sketches with grossly estimated reference points. Positional accuracy issues are exacerbated by the fact that minefield coordinates are in a local datum which must be converted to World Geodetic System - 1984 (WGS 84).

Initial TEC involvement

In order to initiate the data base development, TEC recruited three volunteers to perform the onsite scanning effort. Within a week of a formal announcement, and after securing the proper passports and documentation, the TEC team boarded a plane bound for Frankfurt, Germany. After 1-week of administrative tasks in Germany, including 4 days of Mine Awareness Training in Bavaria, issuance of a complete Army deployment supply issue (TA-50) and purchase of camouflage fatigues, the team flew in a C-130 from Ramstein Air Base to Tuzla.

Upon arriving at Tuzla Air Base with Kevlar helmets, fatigues, flack jackets and combat boots, the team members were escorted to the MAC. After receiving a preliminary briefing from the Officer-In-Charge (OIC), the duffel bags were deposited, equipment was unpacked and the work commenced.

Hardware consisted of three laptop computers, four MaxView PaperPort scanners and power surge protectors. Strategic logistical deployment on a small picnic table made for a cozy working environment. Prior to the commencement of the scanning, a collection methodology was devised. This consisted of an assessment and estimate of workload, a designation of a logical naming convention, a definition of backup storage procedures and a division of responsibilities. Having already become familiar with the scanning process, the TEC team began scanning the documents and continued at a constant 12-hour per day pace for 2 weeks. Approximately 14,000 scans totaling 1,060 megabytes were created.

Problems encountered

Several difficulties were encountered that added a bit of excitement to the mission. These ranged in scope from a simple need for a power strip, to the inability to access the Terrain Team's MSIP in order to archive the scanned data. All of the challenges, however, were overcome through a combination of sheer determination and dumb luck.

The power strip problem was resolved by disabling the local MSIP. The lack of a File Transfer Protocol (FTP) utility was solved by the local system administrator's generous loaning of a network card in exchange for TEC's modem card as collateral. The broken 4 millimeter backup drive at the MAC precipitated a fruitless search for an alternative backup capability. The inability to access the 8 millimeter exabyte drive on the Terrain Team's MSIP (due to accreditation problems) resulted in the use of the local MSIP as a storage device. The lack of power strips required disabling the laptops, reactivating the local MSIP and transferring the files directly from the battery-powered laptop.

An outbreak of irreparable hard disk clusters on the network-enabled laptop required LapLinking to a MAC computer as a bridge to the MSIP. The incredibly slow BAUD rate back to Fort Belvoir, Va., (4 hours to transfer 20 megabytes) rendered simple electronic file transfer impractical. Despite all these setbacks, good luck occurred 3 days prior to the completion of the scans when the MAC received a new Pentium PC with a Floptical Disk Drive. The loan of three 320 megabyte floptical disks alleviated the file archive problem.

From a data standpoint, the quality of the minefield sheet scans varied greatly. Some were crystal clear. Others were such poor photocopies that multiple scans were required in order to achieve a legible scan. Logistically, the estimated workload essentially doubled as the 14,000 sheets were all stapled in groups of two.

Overall results

Despite all the perceived difficulties, the scanning effort was a smashing success. The methodologies developed were continued by the MAC after the departure of the TEC team. One of the scanners was left behind to allow continued data generation. Since July 15, several thousand more scans have been added to the data base.

Minefield data base development continues, though much of the work has been taken over by the various Army components and DOD contractors. The three members of the TEC team have returned to their "real" jobs with first-hand knowledge of the Bosnian situation. The mission, which was enhanced by dust ingestion, fried foods, bats in the stairwell and "optional but highly encouraged" high and tight haircuts, was one deployment which is not likely to be forgotten. (Cliff Jordan, U.S. Army Topographic Engineering Center, CETEC-PD-DT, 7701 Telegraph Road, Alexandria, VA 22315-3864, DSN 328-6748, 703-428-6748 or cjordan@tec.army.mil)

Digital Data Digest is an unclassified information exchange bulletin authorized under the provisions of AR 25-30. The U.S. Army Topographic Engineering Center publishes *Digital Data Digest* quarterly.
Articles and suggestions are welcome from any DOD agency performing work related to military applications of Digital Topographic Data. Internal clearances are the responsibility of the originating agency.
Subscriptions are free to U.S. government agencies upon written request to: Editor, *Digital Data Digest*, U.S. Army Topographic Engineering Center, CETEC-PA, 7701 Telegraph Road, Alexandria, VA 22315-3864, DSN 328-6634, (703) 428-6634 or @http://www.tec.army.mil/tec_organization.html.

Commander and Acting Director . . . . Col. Robert F. Kirby
Public Affairs Officer . . . . Mark K. Ross
Editor . . . . Jackie L. Bryant
DCAC Director . . . . Regis J. Orsinger
Art Editor . . . . Barbara A. Jayne

Army MC&G software reuse effort update

The U.S. Army Topographic Engineering Center (TEC) has been assigned the Army lead for developing a reusable mapping, charting and geodesy (MC&G) software reuse program. This work is being accomplished under a Science and Technology Objective (STO), which was created in FY94. The stated goal of this effort is to increase system interoperability by ensuring that digital topographic data (DTD) can be directly imported and processed using standardized, well-tested, well-documented reusable software.

TEC's solution includes: 1) providing guidelines for designing and documenting reusable software; 2) developing well-tested reusable code (based on these guidelines) which is then available for immediate use, and which provides examples for others wishing to develop reusable code; and 3) developing an MC&G domain model, which highlights opportunities for reuse and provides a framework for integrating MC&G software into various Army systems.

TEC has relied heavily upon the Army Reuse Center (ARC), with contractor support from CACI, to help provide Army input to the Department of Defense (DOD) MC&G domain model, to provide DOD-wide workshops on software reuse principles, and to help prepare written guidance on developing and documenting reusable modules.

Importance of reusable MC&G software

Several factors contribute to the military's increased need for reusable, standard MC&G software. First, the number of consumers of military MC&G data has literally exploded in the past several years. This, in turn, has been fueled by the availability of a greater variety of MC&G data, by improvements in the digital data delivery process, and by a significant reduction in the cost of the hardware needed to exploit this data. Naturally, the demand for software to fully exploit this MC&G data has not been far behind.

A second factor driving the need for software standardization is the familiar stovepipe development problem. Previously, military program managers paid for solutions which were tailored for use within their particular programs — and the government has paid the price in both development and maintenance costs.

With the military now focused strongly on efforts to digitize the battlefield, it has become clear that another disadvantage of the "stovepipe"approach is that independently developed MC&G software tools are often not interoperable. The following example illustrates the potential seriousness of this problem. Suppose a forward-deployed unit reports its position as 30-20-10.2N and 10-10-22.3E, but the receiving unit's software expects three digits in the degrees portion of the longitude, and does not expect dashes between the units (e.g., 010 10 22.3E). In this case, it is conceivable that the receiving software (say an air support mission planning system) might not accept the input, or might incorrectly interpret the coordinates.

Finally, a formal program focused on MC&G software standardization helps to ensure that each user is provided with the right piece of software. Misuse of software and/or misinterpretation of the results can be as serious as misreading a map coordinate. For example, an algorithm which computes Line-of-Sight very well in areas with rolling hills, may not be suitable for use in extremely mountainous country. In such a situation, the software's interpolation routines may add non-existent terrain features, or may neglect to model existing, relatively narrow, features.

Reusable MC&G software now available

TEC has completed a number of popular modules which provide basic MC&G functionality on both DOS/Windows and UNIX platforms. These include importers for standard National Imagery and Mapping Agency digital topographic data (Digital Terrain Elevation Data (DTED), ARC Digitized Raster Graphics (ADRG), Compressed ADRG (CADRG), and Controlled-Image Base (CIB)), as well as coordinate conversion and datum transformation software. In general, this software is engineered for use within other applications, therefore, exotic graphical user interfaces (GUIs) are typically not provided. Included with the software are a Reuser's Manual and test data sets to ensure that the software has been implemented correctly.

The next component to be completed will be the Data Access Library (DAL) for Raster Product Format (RPF). This library provides the user with a means of searching an RPF Volume for the desired image and metadata, extracting the data, and producing image and metadata files suitable for display by standard image display programs. The user may down-sample images, convert images to 16, 32, or 216 colors or gray levels, and combine multiple frames into a single image. Future submissions will assist users in exploiting Vector Product Format data and Digital Terrain Elevation Data.

TEC also has completed its *Handbook for Transformation of Datums, Projections, Grids, and Common Coordinate Systems*. This document replaces the draft MIL-

HDBK 600008, of the same title. The handbook provides general guidance and education on the most important aspects of datum shifts and coordinate conversions. It contains derivations for most of the common equations, updated shift parameters, and introductory information on crucial mapping tools. An added feature is an explanation of the vagaries of the Military Grid Reference System (MGRS). The document has proved popular with military instructors, combat developers and software system engineers at all levels.

Access to reusable MC&G software and associated documents

TEC and ARC have established an on-line MC&G software repository infrastructure which will allow subscribers to electronically extract available MC&G reusable software and associated documents (such as ARC's guidelines for documenting and developing reusable C components). The process is designed to provide primary access to the MC&G software repository through the TEC or ARC Web Pages; however, ARC also will process phone and e-mail requests. TEC and ARC plan to open the MC&G repository by Nov. 1, 1996. At that time interested parties may obtain information on establishing accounts from several sources. Web users may review summaries of available software without opening accounts by viewing the TEC's Digital Concepts and Analysis Center (DCAC) Reusable Software Web Page. The address for this page is: http://www.tec.army.mil/PD/dcac/software.htm.

From this site, users may then link directly to the MC&G repository, under the ARC Web Page, to establish an account. Those without Web access may contact DCAC's Standards Division staff at 703-428-6505 for help in setting up an account.

Related MC&G software reuse efforts

In mid-1995, TEC and the ARC completed the first version of the Army MC&G Domain Definition Report. This work was based on interviews with a broad spectrum of Army organizations, and was extremely useful in identifying high reuse-potential software functionality based on common requirements. The ARC has employed this approach in past efforts with other domains, including logistics, education, and general system services. TEC is using this information to help focus its reusable MC&G software reengineering efforts.

To advance DOD-wide interoperability, TEC and the ARC proposed enlarging the scope of this effort to include the Air Force, Marine Corps and Navy. As a result, a DOD Domain Analysis Working Group (DAWG) was formed under the National Imagery and Mapping Agency Interoperable Map Software program, with representation from each of the Services. This group has recently completed a DOD Domain Definition Report which will undergo formal Service staffing shortly.

Future plans

TEC, working with the ARC, has shown the value of reusable software within the MC&G community, on a relatively small-scale. These types of activities need to be expanded upon to achieve significant savings. Additionally, to ensure success, DOD software developers will need assistance in identifying the resources necessary to produce software engineered for reuse, and will need to feel confidence in the software available in the various reuse libraries. This may require establishing a formal program of MC&G software validation at the Service or DOD level. Finally, more cooperative efforts are needed between DOD and commercial geographic information system (GIS) and desktop mapping software vendors. This will help to ensure that commercial packages used by the military support the standards necessary for accuracy and interoperability.

For more information, contact Richard Joy, U.S. Army Topographic Engineering Center, CETEC-PD-DS, 7701 Telegraph Road, Alexandria, VA 22315-3864, DSN 328-6505, 703-428-6505 or richard.t.joy@usace.army.mil.

Topo Force XXI — meeting needs of the Warfighter

Since March 1995, the U.S. Army Topographic Engineering Center (TEC) and the National Imagery and Mapping Agency (NIMA), along with the assistance of other U.S. agencies (including the National Recon-naissance Office (NRO) and Central Imagery Office (CIO)), have sponsored Topo Force XXI. Topo Force XXI tests and improves the capability of the geospatial information production community to respond to the Army's rapid geospatial data needs.

Exercises test "fixes"

Conceptual production procedures are tested through a series of exercises. Each exercise tests "fixes" to previous exercise issues and interjects new ideas and concepts. To date, three exercises have been conducted: Operations Fremont (May 1995), Meade (December 1995), and Loper (April 1996). These exercises concentrated on refining production methods and product suites to meet short production time frames, as illustrated in the table below which summarizes time and production requirements for Operation Meade.

Producing data for users

Operation Loper was the first exercise to produce data for users; digital topographic data (DTD) was produced for the U.S. Army's 30th Engineer Battalion (Topographic) to support Operation Golden Dragon, an XVIII Airborne Corps exercise. Operation Loper revealed that users, having the capability to modify the DTD as needed, found the data useful. Also, it established the need for extensive testing to establish the data usability limits and to identify "holes" in the vector data.

Testing operational usability

The next exercise, Operation Kirby, will focus on testing the operational usability of the data suite. While the entire process will undergo further refinement, special emphasis in this exercise will be placed on testing. Elements of TEC and operational users alike will subject the data to rigorous evaluation concerning its practicality and usability. The results of this evaluation are expected to help determine the contents and density of geospatial information that the Warfighter needs, when the Warfighter needs it, wherever the Warfighter needs it. (Rick Ramsey, U.S. Army Topographic Engineering Center, CETEC-PD-DR, 7701 Telegraph Road, Alexandria, VA 22315-3864, DSN 328-6784, 703-428-6784 or cramsey@tec.army.mil)

TIME	# AREA	PRODUCT DATA/AREA	ORGANIZATION
2 Hours	(1) 20 km x 20 km	3-D Visualization	TEC
18 Hours	(1) 20 km x 20 km	Rapid DTED LII Image Map (1:50K) MEDS ITD 3-D Visualization	NIMA TEC TEC TEC
	(3) 2 km x 2 km	Rapid DTED LIII Image Map (1:4.5K) 3-D Visualization	NIMA NIMA TEC
72 Hours	(1) 90 km x 90 km	Rapid DTED LII Image Map (1:50K) MEDS ITD	NIMA TEC NIMA and TEC

TEC conducts DTOP accuracy assessment

In December 1995, three members of the Digital Concepts and Analysis Center (DCAC) traveled to Camp Pendleton, Calif., to participate in a field-based evaluation of Digital Topographic Tactical Terrain Data (DTOP). As part of the initiative, TEC developed methodologies for "value-adding" missing attribute information and determining attribute and positional accuracy.

The primary emphasis of this work was to assess the accuracy of the data base and identify and facilitate the level of effort associated with value adding. Methodologies derived from this effort may be applied to future assessments of any attributed vector data sets. DTOP was a logical test case as it is the most richly attributed of the National Imagery and Mapping Agency's (NIMA) suite of vector products.

DTOP is a comprehensive, heavily attributed 1:50,000-scale terrain analysis data base designed to support land combat planning and operations. More than 170 DTOP features were chosen for analysis. Each feature was located in the field using a Precise Lightweight Global Positioning System Receiver (PLGR) in the Precise Positioning Service (PPS) mode (approximately 10-meter horizontal accuracy). Universal Transverse Mercator (UTM) coordinates obtained from the PLGR were annotated for each feature and will be used to facilitate a subsequent horizontal accuracy comparison with coincident DTOP coordinates. DTOP accuracy is expected to be equivalent to that of a 1:50,000-scale Topographic Line Map (50 meters circular @ 90 percent confidence). Preliminary attribute fidelity results are encouraging. Final accuracy results are pending. DCAC will publish the final results in future editions of the *Digital Data Digest.* (Cliff Jordan, U.S. Army Topographic Engineering Center, CETEC-PD-DT, 7701 Telegraph Road, Alexandria, VA 22315 3864, DSN 328-6748, 703-428-6748 or cjordan@tec.army.mil).

DCAC develops new ITD/VITD user's guide

To the new user, Interim Terrain Data (ITD) may seem overwhelming. All of the coverages, features, attributes and attribute values can cause confusion. To alleviate the anxiety, the Digital Concepts and Analysis Center (DCAC) has produced a "user friendly" User's Guide for the data. The *Interim Terrain Data (ITD)/Vector Product Interim Terrain Data (VITD) User's Guide* is intended to be a convenient reference for users of these types of terrain analysis data.

ITD is a digitized version of the standard, 1:50,000-scale Tactical Terrain Analysis Data Base (TTADB) product produced by the National Imagery and Mapping Agency (NIMA). Like TTADB, ITD is comprised of six thematic layers of spatial and feature data. These include: Obstacles, Surface Drainage, Transportation, Surface Configuration (slope), Surface Materials (Soils) and Vegetation. ITD is distributed on 9-track tape in the Standard Linear Format (SLF) using the NIMA Feature File coding scheme (NIMAFF).

VITD is essentially a reformatted, newer version of ITD. NIMA has moved to Vector Product Format (VPF) and the Feature Attribute Coding Catalog (FACC) as its standards for distributing vector-based products. VPF is a data structuring format. FACC is a hierarchically based feature and attribute naming convention. The newer version of ITD in VPF/FACC is VITD.

These and other topics are covered in the *ITD/VITD User's Guide*. Specifically, coding schemes, data structure, file organization, and applications using the data, such as tactical decision aids (TDA), are covered in great detail. Appendices include glossaries for features and attributes, and feature/attribute tables.

To order the guide, contact Lou Fatale, U.S. Army Topographic Engineering Center, CETEC-PD-DT, 7701 Telegraph Road, Alexandria, VA 22315-3864, DSN 328-6748, 703-428-6748 or lfatale@tec.army.mil.

GIS Corner

GIS and GPS: A marriage made in the Heavens

It wasn't easy being a forensic cartographer. Any time a mission went awry because of geographic information system-related problems, Columbo was in the hot seat. He sat glumly in his chair, waiting for the 'Monthly Accident Debrief.' Today, they were reviewing two incidents of canoes going over a waterfall . . . the same waterfall. Greg I. Smith (GIS) lamented, "I had the most detailed information available from the National Imagery and Mapping Agency Level XXX data base. I knew where every rock and branch was. I just couldn't figure out where I was." Geoff P. Swanson (GPS) followed, "I knew my coordinates to the closest centimeter. I just didn't know what was ahead. How was I supposed to know we were about to go over a waterfall?" Columbo sipped his coffee and thought, "Hmmm . . . GPS and GIS . . . GIS and GPS . . . ahh . . . a marriage made in the heavens!"

From Columbo and The Case of the Tippy Canoe

The Global Positioning System (GPS) is a collection of satellites and receivers which provide precise time and position information. Individuals can locate themselves anywhere from within a couple of hundred meters to less than a centimeter, depending on the equipment and techniques used.

GPS and GIS are complementary. GPS provides location and GIS provides context. Knowing where you are without knowing what is around you is of as little value as knowing a great deal about an area when you don't know where you are.

As a relatively new technology, GPS is impacting GIS users' perception and use of spatial data. GPS is changing the way we think about building data bases, by allowing us to update standard product data bases, as well as create 'personal' data bases. In addition, it is affecting our concepts of accuracy in dealing with maps and spatial data bases.

GPS changes data base construction equation

Today, GIS data bases are primarily constructed from imagery using photogrammetric techniques. Images are generally more current than maps, can be obtained quickly, do not require physical access to an area, and can cover territory anywhere from a few square feet to a continent. Despite the large number of advantages, imagery has some drawbacks, including the difficulty in extracting feature information, the relatively high cost of photogrammetric software and hardware, and the extensive training required to use the technology.

GPS changes the data base construction equation with the introduction of readily available, low-cost, easy-to-use receivers which can record both locations and attributes. This creates a environment where anyone can be a mapper! Granted, GPS is not the ultimate positioning solution; there are certain conditions where GPS is ineffective and some training is required (though far less than is required to understand photogrammetry). Still, it is a quantum leap forward.

Updating and customizing data bases

Will GPS replace imagery as a common source of data? The answer is both 'no' and 'yes.' The answer is 'no' because GPS requires that the receiver physically occupy a location to obtain coordination information. You need both the time to move from place to place within an area, as well as access to the area. GPS is just not practical in many instances, particularly in foreign countries.

On the other hand, the answer is 'yes' because you can map anywhere you are (as long as you have remembered your receiver). GPS can be used to update spatial data bases, as well as create 'personal' data bases. Perhaps the road you are driving down is not found in your GIS. You simply collect the coordinates of the road as you drive along and later edit your standard product. In addition, GPS is ideal for the development of 'personal' data bases. For example, you could precisely record the location of a piece of equipment you abandoned on the battlefield in order to go back and retrieve it later. You will no longer be limited to collecting information about features deemed significant by a mapping organization; you can collect information about features which are of interest to you.

GPS as a forcing function for improved GIS data

Despite GPS' utility for data collection, most users employ the technology to simply determine their location and navigate from point to point. An interesting and disconcerting situation occurs when GPS positions conflict with the locations on maps or GIS data bases.

The conflicts arise because maps and data bases built from maps have a built-in inaccuracy. Cartographers use 'cartographic license' to move features to make a map more legible (often up to hundreds of meters on maps covering large areas). This has been acceptable in the past when you had no way of knowing exactly where you were (absolute position) because you oriented yourself by knowing where features were in relation to one another (relative position). Now that you know your absolute position precisely with GPS, maps suddenly seem less accurate. This means that GPS users must resolve any conflicts between their GPS-derived coordinates and map-estimated positions.

Because of the need for correlation between GPS and map coordinates, GPS systems are driving requirements for higher accuracy, improved data. Instead of asking for maps which have built-in 'cartographic license', users are requesting the unedited spatial data collected by mapping organizations. This is causing a significant change in the relationship between map producers and users.

The future

What does the future hold? In the near-term, GPS is forcing users to question the accuracy of their maps and data bases, as well as demanding higher quality data. GPS is more and more being used to update standard data bases as well as create 'personal' data bases. While these are profound changes, we must remember that both GPS and GIS are in their infancy; the synergy between the two technologies is just beginning, and the best is yet to come! (Douglas R. Caldwell, U.S. Army Topographic Engineering Center, CETEC-TD-TD, 7701 Telegraph Road, Alexandria, VA 22315-3864, DSN 328-6775, 703-428-6775 or caldwell@tec.army.mil).

GIS Tips

The following World Wide Web sites provide information on GPS technology and applications:

Trimble Tutorial on GPS **http://www.trimble.com/gps/index.htm**

Overview of GPS **by Peter Dana http://www.utexas.edu/depts/grg/gcraft/notes/gps/gps.html**

Introduction to GPS Applications **by John Beadle http://galaxy.einet.net/editors/john-beadles/introgps.htm**

LAST CALL!

Readers wishing to continue to receive *Digital Data Digest* should fill out and return the subscription renewal form on Page 16. Unless a renewal form is received, your organization/name will be deleted from our distribution list.

Editor's note:

Because *Digital Data Digest* is not yet available on TEC's Home Page, readers who requested an electronic copy of this publication will receive a hard copy until further notice.

As football aficionados know, special team players can be the deciding factor between victory and success, or defeat and failure. In the Digital Concepts and Analysis Center (DCAC), a special team of administrative support members are part of the behind-the-scenes players that help make the center's mission successful.

As a veteran member of DCAC's support team, Darlene Shepherd has worked as the secretary to the DCAC's director since 19??. A native Virginian, Darlene began her government career in 1975 as a secretary with the Naval Air (NavAir) Systems Command Reliability and Maintainability Directorate's Readiness Improvement Office.

Photo #3

4 7/16 x 3

4 3/4 x 3 3/16

93.5%

Darlene

"The office was responsible for monitoring and tracking all naval aircraft, and reporting system failures and equipment requirements. I enjoyed my position with NavAir because I was involved in a variety of assignments," Darlene said. "Today, I don't think secretaries just want to sit and type all day. I want a challenge and variety in my job, in addition to secretarial duties," she explained.

In 1980, Darlene was set to take a position with the fledgling Cruise Missile Program Project Office when she married and relocated with her husband to Camp Lejeune, N.C. While stationed at the Marine Corps base, Darlene accepted a position as a secretary in the Criminal Investigation Division of the Provost Marshal's Office. "That was an exciting job because of the different types of things that I became involved in, like investigations, interrogations and emergency situations," she said.

In June 1981, the mother of two returned to Virginia and joined the U.S. Army Engineer Topographic Laboratories (now the U.S. Army Topographic Engineering Center (TEC)). "I enjoy the low-key atmosphere here at TEC," Darlene said. She also enjoys the occasional function that frees her from strictly secretarial duties. Recently, she provided administrative support to the Consolidated Army Topographic Terrain Analysis and Multispectral Imagery Conference. "I like the fact that my job gives me an opportunity to interact with customers from different Army and DOD agencies," she said.

Also, in the absence of the center's administrative officer, Darlene handles those duties, as well. "Filling in for the admin officer has given me an opportunity to experience another avenue and find out if

Photo #4

4 7/16 x 3

4 3/4 x 3 3/16

93.5%

Sandra

I would like to go in that direction if I ever left the secretarial field," she said.

Although she is a native of Savannah, Ga., Sandra Andino, the secretary for DCAC's Standards Division, spent much of her youth in Germany, stationed with her father, an Army officer, and mother, a native of Germany.

Following graduation from Munich American High School in 1986, Sandra returned to the states where she attended the University of Central Florida and "seriously considered joining the Air Force but, I got married instead," she said. Returning to Europe, Sandra worked in a variety of clerk and secretarial positions. After returning to the states in 1991, she joined the Night Vision Laboratory at Fort Belvoir, Va., as a secretary. In 1992, Sandra left the government to accept a position in private industry as a technical assistant. In April 1994, a colleague at her former job told her about possible job opportunities at TEC. She joined DCAC in October of that year.

"In other secretarial positions I've felt chained to my desk and the phone all day," Sandra said. "In the Standards Division, once the secretarial functions are completed, I have an opportunity to become involved in other computer-related activities, such as hardware maintenance upgrades and repairs, and learning new software programs."

Recently, Sandra was involved in the division's effort to automate office procedures, such as the tracking of the processing of monthly activity reports to make them more accessible to team members.

Currently, she is working toward an associate's degree in information systems technology, with a networking specialty, which she hopes to complete in December 1997. A single mother with a 3 1/2-year-old daughter Ariana, Sandra received a special honor this past summer when she was accepted into Phi Theta Kappa, a national scholastic honor society. "After I get my degree, I plan to continue my education and take advantage of the opportunities for advancement here at TEC."

Photo #5

3 1/2 x 3 1/4

3 x 2 3/4

117%

Susie (Photo by Wayne Marbury.)

Susie Calliotte is the newest member to join the center's Requirements Division. A native of San Diego, Calif., Susie brings a variety of work experience to the division. She began her government career in 1988 as a clerk-typist with the Defense Logistics Agency (DLA), Contract Management. In 1990, she accepted a position as a personnel clerk with the Fort Belvoir Civilian Personnel, Classification Division. In 1991, Susie returned to DLA, Contract Management, this time in a secretarial capacity. During this time frame, she attended college part time and became a certified nursing assistant. But, the combination of work and school took its toll, and she has temporarily put her pursuit of a nursing career on hold.

In 1993, Susie was assigned to the Environmental Support Group, Desert Storm Project as a management assistant. The project's main mission was to collect data to assist Desert Storm troops in submitting claims for symptoms related to the Gulf War Syndrome.

"I assisted in planning a systematic, fact-finding program for the retrieval of records concerning the effects of troop exposure to fumes from burning oil wells," she explained. "This information is being used to help soldiers file medical claims related to Post Traumatic Stress Disorders after being stationed in Saudi Arabia," she continued.

Although she has only been with DCAC for 4 months, Susie best summed up the attitude of both Darlene and Sandra, "I'm eager to tackle any assignment that will help complete the mission."

Col. Robert F. Kirby assumes command of TEC

Col. Robert F. Kirby became the commander and acting director of the U.S. Army Topographic Engineering Center (TEC), Alexandria, Va., on Oct. 31, 1996. He assumed command from Col. Richard G. Johnson who retired

A native of Norfolk, Va., Col. Kirby earned a bachelor of arts degree in geography (cartography) from the University of Illinois in 1968 and a master of science degree in geodetic science (remote sensing and photogrammetry) from Purdue University in 1974. He is a graduate of the Engineer Basic and Advanced Courses, Army Command and General Staff College, and the Army War College.

Upon graduation from the University of Illinois, Col. Kirby received a regular commission in the U.S. Army Corps of Engineers through the Reserve Officer Training Corps as a Distinguished Military Graduate. He completed the Engineer Officer Basic Course in November 1968, and after becoming a distinguished graduate of the U.S. Army Topographic Engineer Officer Course in April 1969, was assigned as an instructor of engineer officer candidates in the Department of Topography, U.S. Army Engineer School (USAES), Fort Belvoir, Va.

After earning his Parachute Badge in March 1970, he reported to Vietnam in May and was assigned as an engineer intelligence officer in the 517th Engineer Detachment (Topographic) in Long Binh, where he participated in the Cambodian Offensive. In November 1970, Col. Kirby became the Commander, B Company, 69th Engineer Battalion (Construction), Can Tho, Vietnam.

Returning to the United States in May 1971, he graduated from the Engineer Officer Advanced Course in February 1972 and became an exchange student at the British Army School of Military Survey in England, graduating in May 1973. After three months of duty as a research and development coordinator at the U.S. Army Engineer Topographic Laboratories (now TEC), he entered graduate school at Purdue University and received his master's degree in August 1974.

In September 1974, Col. Kirby was assigned to the 227th Engineer Detachment (Topographic), Headquarters, U.S. Army, Europe Engineer in Heidelberg, Germany, where he served as the Theater Army Mapping Officer and Detachment Operations Officer.

Upon returning to the United States in September 1977, he became the Operations Officer and Executive Officer of the 30th Engineer Battalion, Fort Belvoir. In February 1979, he became a Senior Project Officer, and a Test and Evaluation Officer in the Directorate of Combat Developments, USAES.

After graduating from the U.S. Army Command and General Staff College as an honor graduate in June 1981, he was assigned to the U.S. Army Staff as the Topographic Programs Officer, Office of the Assistant Chief of Staff, Intelligence, Washington, D.C. In May 1985, he became the Battalion Commander of the 29th Engineer Battalion (Topographic), Fort Shafter, Hawaii.

Following graduation from the U.S. Army War College in June 1988, he became the first Director of the Department of Topographic Engineering at the newly relocated USAES at Fort Leonard Wood, Mo.

In July 1991, Col. Kirby became the Director of the Defense Mapping Agency (DMA) (renamed the National Imagery and Mapping Agency) Hydrographic/Topographic Center (DMAH/TC) in Bethesda, Md. In November 1991, he graduated from Phase II of the Joint Professional Military Education Course, Armed Forces Staff College, Norfolk, Va. Following a Department of Defense-directed reorganization that changed the DMAH/TC Director position to Senior Executive Service, he served as assistant Deputy Director for Operations Requirements, Plans and Requirements Directorate, at Headquarters, DMA from November 1992 to April 1994. From April 1994 to July 1995, he was the Director, DMA Combat Support Center, Bethesda, Md. In July 1995, he became the Director of the DMA Department of Consumer Interface in Bethesda.

Col. Kirby's military awards and decorations include the Bronze Star with oak leaf cluster (OLC), Army Meritorious Service Medal with four OLCs, Army Commendation Medal with two OLCs, Army Achievement Medal, Parachute Badge and Army General Staff Identification Badge. He is a Joint Service Officer.

DCAC Points of Contact
(Commercial 703-428-XXXX; Telefax 703-428-8176)

Mission Areas	POC Name	DSN 328-XXXX
REQUIREMENTS DIVISION		
Command, Control, Communications and Intelligence	James Allen/Brenda Brathwaite	328-6758
Modeling/Simulation and Training	James Ackeret/Don Morgan	328-6784
Area Requirements	Rob Lambert	328-9173
Weapon Systems and Applications	Rick Ramsey/Jeff Harrison	328-6781
Digital Topographic Data Availability	Katherine Ebersole	328-6758
Army Geospatial Information Data Base	Katherine Ebersole	328-6758
Geodesy/Datum Transformations	James Ackeret	328-6784
Modeling and Simulation Terrain Task Force	James Ackeret/Don Morgan	328-6784
High-Resolution Data	Jeff Harrison	328-6781
Rapid Response Data	Rick Ramsey	328-6781
STANDARDS DIVISION		
Army Graphics Exchange Standards	Richard Joy	328-6505
Army Use of Vector Product Format	David Baxter	328-6505
Datum Transformation and Coordinate Conversion Software	Daniel Specht	328-6505
Digital Point Positioning Data Base	Kevin Backe	328-6760
PC-ARC Digitized Raster Graphics	Shane McIntyre	328-6505
Mapping, Charting and Geodesy Software Standardization and Reuse	Richard Joy/John Hale	328-6505
International, National and Federal Geospatial Standardization Activities	Kevin Backe/David Baxter	328-6505
Raster Product Format Exploitation Software	Daniel Specht	328-6505
Vector Product Format Exploitation Software	David Baxter	328-6505
PC Matrix	Robert Atkins	328-6505
SPECIAL STUDIES DIVISION		
Controlled-Image Base	Louis Fatale	328-6785
Compressed ARC Digitized Raster Graphics	Denise Hovanec	328-6785
Digital Data Demonstration System	Denise Hovanec	328-6785
PC-DTED Display Software	Patrick Nguyen	328-6760
Prototype Evaluations	Jeffrey Messmore	328-6748
Interim Terrain Data	Louis Fatale/Bill Ryder	328-6760
Tactical Terrain Data	Louis Fatale	328-6760

Digital Data Digest subscription renewal

The Digital Concepts and Analysis Center is in the process of reviewing the *Digital Data Digest* (*D*^{3}) distribution list. For this reason, we ask all readers to update and return the following form to ensure continued receipt of *D*^{3}. You should also indicate a preference for a hard copy or an electronic copy and include your e-mail address. We will notify you when future issues appear on our home page.

To continue to receive a subscription, please fill out this form.

Preference - circle one: **hard copy** **electronic copy**

Name ______________________________

Position ______________________________

Agency/Organization ______________________________

Address ______________________________

City ______________________________

State and Zip Code ______________________________

Telephone ______________________________

E-mail ______________________________

1. Briefly describe your particular interests in Digital Topographic Data. ______________________________

____

____

2. Are you interested in evaluating prototype digital products from the National Imagery and Mapping Agency?
Yes or No

3. Weapon Systems(s)/Applications: ______________________________

Type(s) of Data Used: ______________________________

Computer Hardware/Software Environment: ______________________________

4. Your comments on this issue and suggestions for future issues. ______________________________

____

____

Mail to: Editor, *Digital Data Digest*
U.S. Army Topographic Engineering Center
ATTN: CETEC-PA
7701 Telegraph Road
Alexandria, VA 22315-3864
Telefax 703-428-8176

Internet subscription request

The U.S. Army Topographic Engineering Center's Public Affairs Office currently is in the process of determining subscriber interest in accessing *Digital Data Digest* via the Internet (World Wide Web). The address for web Internet access is @http://www.tec.army.mil/tec_organization.html. Subscribers who have access to Internet and wish to cancel their subscription for a hard copy should fill out the request form below and mail to: Editor, *Digital Data Digest*, U.S. Army Topographic Engineering Center, CETEC-PA, 7701 Telegraph Road, Alexandria, VA 22315-3864.

Name ______________________________

Agency/Organization ______________________________

Address ______________________________

City ______________________________

State and Zip Code ______________________________

Telephone ______________________________

Project fact sheets available upon request

The following Digital Concepts and Analysis Center fact sheets may be accessed via the U.S. Army Topographic Engineering Center's home page on the World Wide Web at http://www.tec.army.mil. Facts sheets also may be requested by contacting the U.S. Army Topographic Engineering Center, Public Affairs Office, CETEC-PA, 7701 Telegraph Road, Alexandria, VA 22315-3864.

ARC Digitized Raster Graphics (ADRG)

Compressed ARC Digitized Raster Graphics (CADRG)

Controlled-Image Base (CIB)

Digital Chart of the World (DCW)

Digital Feature Analysis Data Level 1 (DFAD 1)

Digital Geographic Information Exchange Standard (DIGEST)

Digital Hydrologic Analysis Data (DHAD)

Digital Point Positioning Data Base (DPPDB)

Digital Terrain Elevation Data Level 1 (DTED 1)

Digital Terrain Elevation Data Level 2 (DTED 2)

Digital Topographic Data (DTD) Standardization

Electronic Chart Updating Manual (ECHUM)

High-Resolution Urban-Specific (HIRUS) Data

Interim Terrain Data (ITD)

PC-Digital Terrain Elevation Data (DTED) Display Software

Planning Interim Terrain Data (PITD)

Tactical Terrain Data (TTD) XX

Terrain Evaluation Module (TEM)

Vector Product Format (VPF)

Vector Smart Map (VMAP)